CHAPTER 6

DETERMINING THE COST-EFFECTIVENESS OF PGR

Section A—General Discussion

6-1. The Importance of Determining Cost-Effectiveness. The previous chapter emphasized the need to consider local conditions and to conduct local testing before adopting PGRs. Even when local conditions and the results of testing seem favorable, however, grounds maintenance practices should not be changed without comparing the costs of the alternatives. This cost-comparison, the demonstrated effects of PGRs, the availability of equipment and trained personnel, and safety should all be considered in deciding the most cost-effective maintenance practice.

6-2. Calculating and Documenting Costs of Alternatives:

a. The calculations described in this chapter can be made easily by hand. They can also be adapted readily to a personal computer. The factors considered are:

(a) The costs of mowing.

(2) The costs of applying PGRs.

(3) The length of time PGRs are expected to suppress the growth of the grass.

(4) The reduction in mowing that is expected when PGRs are used.

b. The calculations are made in four steps. First, the costs per hour are calculated for each type of worker employed in the mowing and spraying operations; next, the cost of the equipment used is calculated on a per hour basis; third, the costs of mowing and spraying operations on specific parcels of land are computed; and, fourth, the savings or cost that would result from using PGRs is computed. Finally, the results are evaluated to determine whether the savings that might be generated would result in real dollar savings, or if, instead, the freed personnel and equipment assets would be used for other worthwhile tasks.

c. Documents on which the calculations can be made are provided in attachments 22 through 25. Document A (attachment 22) is used to determine the hourly costs of personnel. Document B (attachment 23) is used to determine the hourly costs of equipment. Using the hourly costs of personnel and equipment, the grounds maintenance manager can use document C (attachment 24) to calculate the costs of mowing and spraying operations on particular parcels of land. Document D (attachment 25) is then used to compare costs and to determine the cost-effectiveness of using PGRs.

d. Documents A through D can also be used to calculate and compare the costs of other maintenance practices and equipment, to prepare budgets, and to determine manpower requirements.

6-3. An Illustrative Example. The use of documents A through D is illustrated in the remainder of this chapter with a fictitous example. Air Base Somewhere is located in the temperate zone, and PGRs are being considered for use on cool-season grasses on 2300 acres. The requirement without PGRs is to mow the parcels shown in table 6-1 every 2 weeks. In addition to the grass, there are large concentrations of weeds that would have to be controlled before the full effect of the plan growth regulators could be realized.

Table 6-1. Mowing Requirement at Air Base Somewhere.

Parcel No.	Description	Size	Equipment Used	Capability of Equipment
1	Runway & Taxiways	2,000 acres	Tractor Mower	2.5 a/h
2	Drainage Areas	200 acres	36" Riding Mower	0.5 a/h
3	Obstructed Areas	100 acres	21" Power Mower	1.15 a/h
4	Fence Borders	100,000 ft^2	Weedeater	1,615 ft^2/h

Section B—Determining Costs

6-4. Personnel Costs:

a. Document A (attachment 22) is used to record the hourly costs of the different types and grades of workers that will be used. Four basic types of workers are:

(1) Hourly Wage Workers. These are temporary helpers that are hired during the peak growing seasons. They do not accrue certain benefits, such as hospitalization and retirement. The composite wage scale for these workers is normally prescribed by the local command.

(2) Civil Service Employees. These are permanent employees hired under civil service regulations. They are entitled to civil service benefits.

(3) Military Personnel. These are active duty personnel assigned to grounds maintenance.

(4) Contractor-Supplied Labor. These are personnel that are supplied by local contractors. The labor costs are determined locally.

b. The costs of the different types of workers are recorded in dollars per hour and include both wages and benefit costs. Benefits include leave and holidays, incentive awards, and the employer's share of payments for insurance, retirement, social security, taxes, and the like. The costs of benefits are allocated to each worker on the same hourly basis as regular pay. The pay and benefits are summed to produce the hourly composite rate for each type of worker. When completed, document A is a catalog of operator and supervisor costs that can be used to determine personnel costs for different pieces of equipment and operations.

c. To estimate military and civil service personnel costs, use AFR 173-13, US Air Force Cost and Planning Factors; AR 37-115, Financial Administration—Accounting for Special Facilities Engineering Projects; and DA Pamphlet 420-6, Facilities Engineering—Resource Management System. Base budget, personnel, and contracting offices can also help in determining personnel costs.

d. The completed document A for the example of Air Base Somewhere is shown in figure 6-1. It shows the pay rates of all the types of personnel who would be used in the example.

e. If growth regulators were to reduce the amount of labor required for mowing, there would not necessarily be a reduction in the budget. If growth regulators permitted a grounds manager to reduce pesonnel in mowing operations, he or she would be able to dip lower into his or her priority list and accomplish other tasks. The calculations would show a savings in labor costs, but the labor and equipment, and thus the costs, might be assigned to other tasks.

f. The use of military personnel for the task poses the question of whether their labor cost should be charged at military pay scales. If there are military requirements to staff the base at a specific level to perform functions in wartime, then there is the possibility that there will be military manpower surpluses during peacetime. Under these circumstances, military labor in peacetime could be considered a free good. In the cost model presented here, however, costs represent the assignment of resources to specific tasks rather than signaling areas of budget reduction; and, therefore, military personnel are included in the costs.

6-5. Equipment Costs:

a. Document B (attachment 23) is used to calculate the hourly costs of the different types of equipment to be used. If desired, document Bs can be completed to create a catalog of equipment costs for all the different types of equipment the base uses in ground maintenance, such as weedeaters, small riding mowers, hand-operated lawn mowers, and the different types of tractor mowers.

b. The entries on document B are made as follows:

(1) Lines 1a to 1e. The purchase price of equipment (line 1a) should be available in local records. The purchase price usually quoted will include the freight on board (f.o.b.) charge but not the charge for shipping from the warehouse to the base. Add any shipping charges to the purchase cost. The service life in years (line 1b) is estimated for each type of equipment. Local experience may be used, particularly if local operating conditions are adverse; or normal service lives can be taken from Office of Management and Budget (OMB) Circular No. A-76, "Performance of Commercial Activities." An estimate of the number of hours the equipment is operated each year (line 1c) is then used to calculate the equipment's service life in hours (line 1d). The hourly investment cost of each piece of equipment (line 1e) is calculated by dividing its purchase cost (line 1a) by its estimated service life in hours (line 1d).

(2) Lines 2a to 2c. The fuel cost per hour (line 2c) is calculated by multiplying the estimated fuel consumption of the equipment per hour (line 2a) by the local cost of fuel (line 2b).

DOCUMENT A*

Personnel Cost Factors

Place: Air Base Somewhere Date: 08/03/84

		A	B	C	D
1.	Temporary Worker				
	Grade	Basic WG-2	Step 1 WG-4	WG-6	WS-6
	Basic pay	$ 8.30	$ 9.08	$ 9.86	$ 13.29
	Benefits**	+ 2.24	+ 2.45	+ 2.66	+ 3.58
	Composite pay	$ 10.54	$ 11.53	$ 12.52	$ 16.87
2.	Permanent Employee				
	Grade	GS-1	GS-2	GS-3	GS-7
	Basic pay	$ 4.61	$ 5.10	$ 5.89	$ 9.66
	Benefits**	+ 0.64	+ .72	+ .83	+ 1.36
	Composite pay***	$ 5.25	$ 5.82	$ 6.72	$ 11.02
3.	Military Member				
	Rank	E-1	E-2	E-3	E-6
	Composite pay***	$ 5.02	$ 5.62	$ 6.31	$ 10.48
4.	Contract Labor				
	Type	Basic Worker	Supervisor		
	Hourly rate	$ 6.50	$ 12.50	$	$

*Fill in skill levels that might be used in applicable grounds maintenance roles, and give costs in dollars/hour. Hourly costs are based on local conditions. Use additional sheets if necessary.
**Include any quarters allowance, incentive awards, employer's share of payment for insurance, retirement, FICA, health insurance, taxes, and similar payments. Individual benefit costs should be calculated on an hourly basis, summed, and recorded here.
***Published in AFR 173-13, AR 37-115, and DA Pamphlet 420-6.

Figure 6-1. Personnel Cost Factors for "Air Base Somewhere."

(3) Line 3a to 3c. Maintenance costs include all labor and parts, including lubricants, blades, cutting line, etc., used to maintain and repair the equipment. The costs of labor and parts can be determined by examining local maintenance records for any period of time, but an annual basis will probably be most convenient. The labor and parts for the piece or type of equipment for that period of time are each divided by the estimated service hours of the equipment for the same time period to arrive at the labor (line 3a) and parts (line 3b) costs per operating hour. The sum of these costs is the total maintenance cost per operating hour (line 3c).

(4) Line 4. The total equipment cost per hour of operation is the sum of the investment, operating, and maintenance costs per operating hour. (Note that the costs of PGRs and herbicides are not calculated here. They are considered in document C.)

c. The completed document B for the example of Air Base Somewhere is shown in figure 6-2. In this example, comparing the cost of mowing with the cost of using a PGR requires costing out four types of mowing equipment and one type of spraying equipment. The line entries are fictitious and are only meant to illustrate the method of calculation. Equipment costs will

vary at each base. Operating and maintenance costs are influenced by the local price of fuel, the climate, the terrain, local operator experience, and other factors.

6-6. Cost of Grounds Maintenance Operations:

a. Document C (attachment 24) is used to calculate the cost of a maintenance operation on a specific parcel of land. It has space for two different types of equipment and for personnel with two different pay scales. More types of equipment and personnel can be accommodated with additional columns or forms. The location and size of the parcel and the operation being costed should be identified on the form, as should any special characteristics of the parcel, such as "rocky and hilly," "fire break," etc. Separate columns are used for each piece of equipment.

DOCUMENT B

Equipment Cost Factors*

Place: Air Base Somewhere Date: 08/03/84

		Types of Equipment			
		TRACTOR MOWER	36" RIDING MOWER	21" POWER MOWER	
1.	Investment Cost				Source**
	a. Purchase cost (total)	$8400.00	$2600.00	$ 420.00	
	b. Service life (years)	12	3	3	***
	c. Expected use (hours/year)	480	480	480	local records
	d. Service life (hours)	5760	3840	1440	(1b) × (1c)
	e. Investment cost ($/hour)	$ 1.46	$ 0.68	$ 0.29	(1a) ÷ (1d)
2.	Operating Cost Per Hour				
	a. Fuel consumption (gal/hour)	2.40	0.80	0.25	****
	b. Cost of fuel ($/gal)	$ 1.00	$ 1.00	$ 1.00	local records
	c. Fuel cost ($/hour)	$ 2.40	$ 0.80	$ 0.25	(2a) × (2b)
3.	Maintenance Cost Per Operating Hour				
	a. Labor cost ($/hour)	$ 5.60	$ 2.80	$ 2.50	local records
	b. Parts cost ($/hour)	$ 9.00	$ 4.50	$ 2.00	local records
	c. Total cost ($/hour)	$ 14.60	$ 7.30	$ 4.50	(3a) + (3b)
4.	Total Equipment Cost per Hour of Operation	$ 18.46	$ 8.78	$ 5.04	(1e) = (2c) + (3c)

*Fill in types of equipment that might be used in applicable grounds maintenance operations, and give costs in dollars/hours.

**This column indicates the source of information. The figures in parentheses indicate lines of this document.

***Local conditions prevail. Guidelines are provided in Office of Management and Budget (OMB) Circular No. A-76, "Performance of Commercial Activities," August 1983.

****Based on local experience or manufacturers' manuals.

Figure 6-2. Equipment Cost Factors for "Air Base Somewhere."

DOCUMENT B

Equipment Cost Factors*

Place: Air Base Somewhere Date: 08/03/84

Types of Equipment

		Weedeater	Spray Equipment		
1.	Investment Cost				Source**
	a. Purchase cost (total)	$360.00	$2600.00	$	
	b. Service life (years)	3	8		***
	c. Expected use (hours/year)	288	480		local records
	d. Service life (hours)	864	5760		(1b) × (1c)
	e. Investment cost ($/hour)	$ 0.42	$ 0.68	$	(1a) ÷ (1d)
2.	Operating Cost Per Hour				
	a. Fuel consumption (gal/hour)	0.12	0.80		****
	b. Cost of fuel ($/gal)	$ 1.00	$ 1.00	$	local records
	c. Fuel cost ($/hour)	$ 0.12	$ 1.80	$	(2a) × (2b)
3.	Maintenance Cost Per Operating Hour				
	a. Labor cost ($/hour)	$ 1.25	$ 2.80	$	local records
	b. Parts cost ($/hour)	$ 0.25	$ 4.50	$	local records
	c. Total cost ($/hour)	$ 1.50	$ 7.30	$	(3a) + (3b)
4.	Total Equipment Cost per Hour of Operation	$ 2.04	$ 8.78	$	(1e) = (2c) + (3c)

*Fill in types of equipment that might be used in applicable grounds maintenance operations, and give costs in dollars/hours.

**This column indicates the source of information. The figures in parentheses indicate lines of this document.

***Local conditions prevail. Guidelines are provided in Office of Management and Budget (OMB) Circular No. A-76, "Performance of Commercial Activities," August 1983.

****Based on local experience or manufacturers' manuals.

Figure 6-2. Continued

b. The line entries are made as follows:

(1) Lines 1a to 1d. These lines are used to calculate the equipment costs of the maintenance operation. Hourly operating costs from document B are entered on line 1a for each type of equipment to be used. Then, an estimate of how many hours it would take to treat an acre with each type of equipment in the kind of terrain found in the parcel is entered on line 1b. The number of acres to be treated with each type of equipment is entered on line 1c. The cost of using each type of equipment is obtained by multiplying line 1a by line 1b and by line 1c and is entered on line 1d. The total equipment cost for the maintenance operation is also entered on line 1d.

(2) Lines 2a to 2d. These lines are used to calculate the costs of spraying PGRs, and are only completed for that particular operation. On line 2a, the gallons per acre of the PGR is entered. Line 2b is the cost per gallon of the PGR, and line 2c is the number of acres to be

treated. The product of these three lines is entered on line 2d. The total chemical cost of the maintenance operation is also entered on line 2d.

(3) Lines 3a to 3k. These lines are used to calculate labor costs for each type of work and equipment. The operator hours for each type of equipment is calculated by multiplying line 1b by line 1c and is entered on line 3b. The equipment operator's estimated time spent traveling between the maintenance yard and the work site, waiting for transportation, loading and unloading equipment, and any other unproductive time, is subtracted from the workhours scheduled per day. The resulting number of productive operator hours per workday is entered on line 3c. The number of operator days required for the maintenance operation is calculated by dividing line 3b by line 3c, and this is entered on line 3d. The total number of operator hours required is then obtained by multiplying line 3d by the number of operator hours per workday (normally 8), and this is entered on line 3e. The foregoing procedure ensures that the labor cost includes all idle or unproductive time. The hourly labor cost for the type of worker is taken from document A and is entered on line 3f. Operator costs are calculated by multiplying line 3e by 3f and are entered on line 3g. Supervisory costs are estimated in a similar manner and are entered on lines 3h, 3i, and 3j.

(4) Lines 4a to 4j. These lines are used to calculate the cost of transportation to and from the work site. An estimate of the number of round trips required to service the operation at the site is entered on line 4a. The miles traveled in one round-trip are entered on line 4b. The total miles to be traveled is the product of lines 4a and 4b and is entered on 4c. Tractor mowers and tractor sprayers are usually driven to and from the work site by their operators. For these, enter the total hours of travel time on line 4c and the total cost per hour from document B on line 4d. For the trucks needed to transport other equipment and operators, enter the total miles traveled on line 4c and the vehicle cost on line 4d. Account for all the vehicles used. The vehicle costs per mile are estimated from figures available locally and include investment, operating, and maintenance costs, as discussed in the instructions for document B. Line 4c is multiplied by line 4d to obtain the total vehicle cost, which is entered on line 4e. The truck drivers' time is entered on line 4g, based on the number of hours needed for a round-trip to the site (line 4f) and the number of round-trips (line 4a). The hourly driver cost, from document A, is entered on line 4h. The total driver cost is the product of lines 4g and 4h, and is entered on line 4i. This cost is added to the vehicle costs (line 4e) to provide the total transportation cost on line 4j. Tractor drivers' travel time was accounted for as non-productive time in 3e, so it is not included again in 4g.

(5) Lines 5a to 5e. The equipment, chemical, labor, and transportation costs on lines 1d, 2d, 3k, and 4j are entered on lines 5a, 5b, 5c, and 5d and are summed to obtain the total cost of the maintenance operation. This is entered on line 5e.

c. The completed document C for the mowing operation in our example of Air Base Somewhere is shown in figure 6-3. Four kinds of mowing equipment were used. A tractor mower mowed the large grassy areas around the main runway and taxiways, 36-inch riding mowers operated on the inclined drainage areas, and 21-inch power mowers and weedeaters mowed smaller areas. Their costs are calculated individually and are totaled at the bottom of the document. We will explain the calculations line-by-line:

(1) Equipment Costs. Line 1a shows the operating costs of the tractor mower and 36-inch riding mower. These figures are obtained from line 4 of document B (figure 6-2). On line 1b, the number of hours required to maintain one acre of each type of area is estimated. The tractor mower is estimated to mow 2.5 acres per hour, or to take 0.4 hours for an acre. The riding mower requires 2 hours to mow an acre. The parcel sizes of 2000 and 200 acres are shown on line 1c. Multiplying the three lines, 1a, 1b, and 1c, yields the equipment cost for mowing each parcel. Those figures are entered on line 1d. The equipment costs for the 21-inch power mowers and the weedeaters were calculated similarly.

(2) Labor Costs.

(a) Line 3b shows the estimated time to complete the job with tractor mowers to be 800 hours (the product of lines 1b and 1c). Line 3c is the productive hours per workday. This is the scheduled hours per day, less the nonproductive time used in getting people organized in the morning, waiting for the trucks, loading the equipment, being transported to the site, unloading the equipment, and getting into operation. In the evening, the process is repeated as the equipment is secured and returned to the storage yard. The nonproductive time is estimated in our

DOCUMENT C

Cost of Grounds Maintenance Operations

Place: Air Base Somewhere Date: 08/03/84

Location: Runways and Taxiways

Type of area:	Grass Turf		Unimproved Drainage Ways			
Size of area:	2000 acres		200 acres			
	Types of Equipment					*Source**
	Tractor Mower		36" Riding Mower			
1. Equipment Costs						
a. Cost per operating hour	$ 18.46		$ 8.78			Document B
b. Equipment-hours per acre	0.4		2.0			
c. Acres mowed (or other)	2000		200			
d. EQUIPMENT COST	$14,768	+	$3,512	=	$18,280.	(1a) × (1b) × (1c)
2. Chemical Costs						
a. Gallons per acre	N/A					
b. Cost per gallon	$ N/A		$			
c. Acres treated	N/A					
d. CHEMICAL COST	$	+	$	=	$	(2a) × (2b) × (2c)
3. Labor Costs						
a. Type of Labor	WG-4		BASE H/W			Document A
b. Working operator-hours required	800		400			(1b) × (1c)
c. Productive operator-hours per day	6		6			**
d. Operator-days required	133		67			(3b) ÷ (3c)
e. Total operator-hours required	1066		534			(3d) × (8 hours per day)
f. Labor cost per hour	$ 11.53		$ 9.55			Document A
g. Operator cost	$12,290.98	+	$5,099.70	=	$17,390.68	(3e) × (3f)

Figure 6-3. Cost of Mowing Operations for "Air Base Somewhere."

							Source*
	h. Supervisor-hours required	80		—			
	i. Supervisor cost per hour	$ 16.87		$ —			Document A
	j. Supervisor cost	$1,349.60	+	$ —	=	1,349.60	(3h) × (3i)
	k. LABOR COST					$18,740.28	(3g) + (3j)
4.	Transport Costs						
	a. No. round trips to site	133		68			3(d) × 2
	b. Rnd. trip miles to site	6		6			
	c. Total hours or miles***	79.8		408			(4a) × (4b)
	d. Vehicle cost per hour or mile***	18.46		0.35			
	e. Total vehicle cost	$1,473.11	+	$142.80	=	$ 1,615.91	(4c) × (4d)
	f. Rnd. trip hours to site	—		1			
	g. Total drive time	—		68			(4a) × (4f)
	h. Drive cost per hour	—		$ 11.53			
	i. Total driver cost	—	+	$784.04	=	$ 784.04	(4g) × (4h)
	j. TRANSPORT COST =		+		=	$ 2,399.95	(4e) + (4i)
5.	Total Cost of Maintenance Operations (sum all applicable Document Cs)						
	a. Equipment cost					$18,280.00	(1d)
	b. Chemical cost						(2d)
	c. Labor cost					$18,740.28	(3k)
	d. Transport cost					2,399.95	(4j)
	e. TOTAL COST					$39,420.23	(5a) + (5b) + (5c) + (5d)
	f. SUM OF DOCUMENT Cs						

*The figures in parentheses indicate lines of this document.

**Nonproductive time includes time used in transport to and from the work site, refueling and greasing equipment, and making repairs and adjustments. This time is subtracted from the normal 8-hour day to derive "productive operator-hours per day."

***Computed on an hourly basis for tractormowers if they are the prime movers of the mowers to and from the work site. The tractor-drivers' time is included in the 2 hour "nonproductive time" or in-transit time and is therefore not included again in 4g.

Figure 6-3. Continued.

DOCUMENT C

Cost of Grounds Maintenance Operations

Place: Air Base Somewhere Date: 08/03/84

Location: Runways and Taxiways

Type of area:	Obstructed Areas		Fence Borders			
Size of area:	100 acres		100,000 sq. ft.			
	Types of Equipment					*Source**
	21" Power Mower		Weedeater			
1. Equipment Costs						
a. Cost per operating hour	$ 5.04		$ 2.04			Document B
b. Equipment-hours per acre	6.67		.00062 per sq. ft.			
c. Acres mowed (or other)	100		100,000 sq. ft			
d. EQUIPMENT COST	$3,361.68	+	$126.48	=	$ 3,488.16	(1a) x (1b) x (1c)
2. Chemical Costs						
a. Gallons per acre	N/A					
b. Cost per gallon	$ N/A		$			
c. Acres treated	N/A					
d. CHEMICAL COST	$	+	$	=		(2a) x (2b) x (2c)
3. Labor Costs						
a. Type of Labor	WG-2		WG-2			Document A
b. Working operator-hours required	667		62			(1b) x (1c)
c. Productive operator-hours per day	6		6			**
d. Operator-days required	111		10			(3b) ÷ (3c)
e. Total operator-hours required	888		80			(3d) x (8 hours per day)
f. Labor cost per hour	$ 10.54		$ 10.54			Document A
g. Operator cost	$9,359.52	+	$ 43.20	=	$10,202.72	(3e) x (3f)
						*Source**
h. Supervisor-hours required	—		—			

Figure 6-3. Continued

i. Supervisor cost per hour	$ —		$—			Document A
j. Supervisor cost	$ —	+	$—	=	—	(3h) × (3i)
k. LABOR COST					$10,202.72	(3g) + (3j)
4. Transport Costs						
a. No. round trips to site	56		4			3(d) × 2
b. Rnd. trip miles to site	6		6			
c. Total hours or miles***	336		24			(4a) × (4b)
d. Vehicle cost per hour or mile***	0.35		0.35			
e. Total vehicle cost	$117.60	+	$ 8.40	=	$ 126.00	(4c) × (4d)
f. Rnd. trip hours to site	1		1			
g. Total drive time	56		4			(4a) × (4f)
h. Drive cost per hour	11.53		$11.53			
i. Total drive cost	645.68	+	$46.12	=	$ 691.80	(4g) × (4h)
j. TRANSPORT COST =		+		=	$ 817.80	(4e) + (4i)

5. TOTAL COST OF MAINTENANCE OPERATIONS (sum all applicable Document Cs)			
a. Equipment cost		$ 3,488.16	(1d)
b. Chemical cost			(2d)
c. Labor cost		$10,202.72	(3k)
d. Transport cost		817.80	(4j)
e. TOTAL COST		$14,508.68	(5a) + (5b) + (5c) + (5d)
f. SUM OF DOCUMENT Cs		$53,928.91	

*The figures in parentheses indicate lines of this document.

**Nonproductive time includes time used in transport to and from the work site, refueling and greasing equipment, and making repairs and adjustments. This time is subtracted from the normal 8-hour day to derive "productive operator-hours per day."

***Computed on an hourly basis for tractormowers if they are the prime movers of the mowers to and from the work site. The tractor-drivers' time is included in the 2 hour "nonproductive time" or in-transit time and is therefore not included again in 4g.

Figure 6-3. Continued.

example to be 2 hours per day. Therefore, the normal 8-hour day is reduced to 6 productive workhours. Six is divided into the required 800 hours of tractor mowing time to obtain the number of operator days that are required, 133.3, which is entered on line 3d. The number of days required, 133.3, is multiplied by the scheduled hours per day, 8, and shows that 1,066 total operator hours must be budgeted to accomplish the job. This figure is entered on line 3e.

(b) The labor costs on line 3f are taken from document A (figure 6-1). A worker at the WG-4 grade level is used as the tractor opera tor. An hourly wage worker, hired on a temporary basis, operates the riding mower. The

operator cost computed on line 3g is $12,290.98 (1,066 hours x $11.53 per hour) for the tractor mower and $5,099.70 for the riding mower. Operator costs for the 21-inch power mower and the weedeater are computed similarly.

(c) The cost of providing a supervisor is calculated on lines 3h, 3i, and 3j. In this case, it is assumed that one supervisor will handle all four operations on a full-time basis and that the job will take 2 weeks to complete. The supervisor is a WS-6, and document A (figure 6-1) indicates this wage to be $16.87 per hour. The 80-hour work period costs $1,349.60 for the supervisor, as shown on line 3j. The supervisor cost and operator costs are combined in the total column to produce a total labor cost of $28,943.00 on line 3k.

(3) Transportation Costs:

(a) The tractor mower is driven to the site by its operator. Line 3d indicates that it must be driven to the work site 133 times, and this is entered on line 4a. In 133 trips, it is driven 798 miles, and at 10 miles an hour this takes 79.8 hours. Document B (figure 6-2) shows that the tractor operating cost is $18.46 per hour, so the 79.8 hours spent traveling to and from the site incurs a cost of $1,473.11, which is entered on line 4e.

(b) The calculations for those operations requiring trucks to transport workers and equipment to the site are somewhat different. The trucks are assumed to take them to the work site in the morning and to pick them up in the afternoon. Therefore, the trucks make two round trips each day. The riding mowers need 67 mower-days to do the job (line 3d) and thus require 34 truck-days since each truck transports 2 riding mowers. At 2 round-trips per truck per day, 68 total round-trips are required. This is entered on line 4a. Line 4b shows an average round-trip distance of 6 miles, yielding a total of 408 miles on line 4c. A cost of $0.35 per mile for the truck, multiplied by the 408 miles, gives us a cost of $142.80, which is entered on line 4e.

(c) The truck drivers will spend about an hour driving over to pick up the riding mowers, waiting as they are loaded, driving them to the site, and returning. This 1 hour figure is shown on line 4f. This figure is multiplied by the number of round-trips (line 4a), and the result, 68, is entered on line 4g. The truck drivers are WG-4s, with a composite pay rate of $11.53 per hour, as shown by document A (figure 6-1). This figure is entered on line 4h. The total driver cost of $784.04 (68 hours x $11.53 per hour) is entered on line 4i. T he transportation costs for the 21-inch power mowers and the weedeaters are computed similarly. There is no driver cost for the tractor mowers since their time spent driving to and from the site was accounted for earlier in their nonproductive time. Transportation costs are totaled on line 4j.

(4) Total Cost. The total mowing cost of $53,928.91 is shown on line 5f.

d. The completed document C for applying a PGR in our example is shown in figure 6-4. The calculations are made in the same way as for the other operations. The cost of the PGR (and herbicides, if needed) is calculated under line 2. It is the dominant cost factor in the spraying operation.

(1) The gallons per acre are, in our example, a combined PGR and herbicide. (The two could be calculated separately, if they were applied that way.) In this case, a gallon covers 5 acres, so only 0.2 gallons are required per acre (line 2a). The cost of the combined agents is estimated at $78,00 per gallon (line 2b), and the operation is to cover the total area of 2300 acres (line 2c). The total chemical cost on line 2d is the product of lines 2a, 2b, and 2c.

DOCUMENT C

Cost of Grounds Maintenance Operations

Place: Air Base Somewhere Date: 08/03/84

Location: Runways and Taxiways

Type of area:	Runway Areas	

Figure 6-4. Cost of PGR Application for "Air Base Somewhere."

Size of area: 2300acres

		Types of Equipment				*Source**
		Spray Equipment				
1.	Equipment Costs					
	a. Cost per operating hour	$ 8.78	$			Document B
	b. Equipment-hours per acre	0.20				
	c. Acres mowed (or other)	2,300				
	d. EQUIPMENT COST	$4,038.80	+ $	=	$ 4,038.80	(1a) × (1b) × (1c)
2.	Chemical Costs					
	a. Gallons per acre	0.20				
	b. Cost per gallon	$ 78.00	$			
	c. Acres treated	2300				
	d. CHEMICAL COST	$	+ $	=	$35,880.00	(2a) × (2b) × (2c)
3.	Labor Costs					
	a. Type of Labor	WG-4				Document A
	b. Working operator-hours required	460				(1b) × (1c)
	c. Productive operator-hours per day	6				**
	d. Operator-days required	77				(3b) ÷ (3c)
	e. Total operator-hours required	614				(3d) × (8 hours per day)
	f. Labor cost per hour	$ 11.53	$			Document A
	g. Operator cost	$7,079.42	+ $	=	$ 7,079.42	(3e) × (3f)
						*Source**
	h. Supervisor-hours required	80				
	i. Supervisor cost per hour	$ 16.87	$			Document A
	j. Supervisor cost	$1,349.60	+ $	=	1,349.60	(3h) × (3i)
	k. LABOR COST				$ 8,429.02	(3g) + (3j)
4.	Transport Costs					
	a. No. round trips to site	77				3(d) × 2
	b. Rnd. trip miles to site	6				
	c. Total hours or miles***	462				(4a) × (4b)

Figure 6-4. Continued.

d. Vehicle cost per hour or mile***	0.35					
e. Total vehicle cost	$161.70	+		=	$ 161.70	(4c) x (4d)
f. Rnd. trip hours to site	1					
g. Total drive time	77					(4a) x (4f)
h. Drive cost per hour	$ 11.53					
i. Total drive cost	$887.81	+		=	$ 887.81	(4g) x (4h)
j. TRANSPORT COST =		+		=	$ 1,049.51	(4e) + (4i)

5. TOTAL COST OF MAINTENANCE OPERATIONS (sum all applicable Document Cs)			
a. Equipment cost		$39,918.80	(1d)
b. Chemical cost			(2d)
c. Labor cost		$ 8,429.02	(3k)
d. Transport cost		1,049.51	(4j)
e. TOTAL COST		$49,397.33	(5a) + (5b) + (5c) + (5d)
f. SUM OF DOCUMENT Cs		$49,397.33	

*The figures in parentheses indicate lines of this document.

**Nonproductive time includes time used in transport to and from the work site, refueling and greasing equipment, and making repairs and adjustments. This time is subtracted from the normal 8-hour day to derive "productive operator-hours per day."

***Computed on an hourly basis for tractormowers if they are the prime movers of the mowers to and from the work site. The tractor-drivers' time is included in the 2 hour "nonproductive time" or in-transit time and is therefore not included again in 4g.

Figure 6-4. Continued.

(2) This part of the analysis should receive special attention because of the variations in price and effectiveness of PGRs. The choice of a PGR will depend on both the PGR's cost and its effectiveness under local conditions. A PGR which may be more effective on a pound-per-acre basis may not be recommended because of its disproportionately greater cost. (Mefluidide is about equal to maleic hydrazide in terms of equivalent cost.)

Section C—Determining Cost-Effectiveness

6-7. Effectiveness-Rates and Effectiveness-Periods of PGRs. It is necessary to know how much and how long a PGR is likely to suppress the growth of grass before we can estimate its cost-effectiveness.

a. We will assume that prescribed application procedures are followed and that the effectiveness of a PGR can be expressed in terms of an effectiveness-rate and an effectiveness-period. These terms provide a basic description of how much a PGR application is expected to reduce plant growth and, thus, mowing requirements, over a certain period of time.

b. The effectiveness-rate is simply the percentage by which total growth will be reduced over a specified period of time. The specified period of time is the effectiveness-period. For example, if a PGR application would reduce total growth by 50 percent over an 8-week period, then the effectiveness-rate would be 50 percent, and the effectiveness-period would be 8 weeks. We can specify either the effectiveness-rate or the effectiveness-period and then estimate the other based on local experience, manufacturers' literature, or research reports.

c. Data on the effectiveness of PGRs, and the normal mowing frequencies on military bases, indicate that using an effectiveness-rate of 50 percent is reasonable under most circumstances. The corresponding effectiveness-periods of currently available PGRs are given in table 6-2.

d. There are many factors that influence the effectiveness of PGRs. Two of the more significant are climatic conditions and the type of grass being controlled. These factors were considered in determining the effectiveness-periods in table 6-2.

Table 6-2. Effectiveness-Periods of PGRs on Grass.

Type of Grass	PGR	EFFECTIVENESS-PERIOD (Weeks) Spring	Summer	Fall
Cool-Season Grasses*	Amidochlor	7	5	7
	Flurprimidol	10	8	10
	Maleic hydrazide	8	6	8
	Mefluidide	8	6	8
Warm-Season Grasses**	Flurprimidol	10	8	10
	Maleic hydrazide	4-6	4-6	4-6
	Mefluidide	6	6	6

*Cool-Season Grasses:
Annual and Kentucky bluegrasses, tall and red fescues, perennial ryegrass, timothy, and bromegrasses.

**Warm-Season Grasses:
Bahiagrass, bermudagrasses, zosiagrass, centipedegrass, St. Augustinegrass, kikuyugrass (not labeled for maleic hydrazide), and carpetgrass.

Note: Orchardgrass, velvetgrass, and tall oatgrass are not affected by PGRs. Performance of the commercially available PGRs in regions where these grasses do not enter a state of winter dormancy has been erractic, and the use of PGRs is usually not recommended.

6-8. Calculating the Cost-Effectiveness of Using PGRs:

a. Document D (attachment 25) is used to compare maintenance costs with and without usisng PGRs. The general information at the top of the document should be recorded so that the cost comparison can be retained for future reference.

(1) Line 1. The effectiveness-period is discussed in paragraph 6-7. Table 6-2 may be used for the PGRs and conditions listed therein.

(2) Line 2. The normal interval between mowings is based on local requirements.

(3) Line 3. The number of mowings that would normally be required during the effectiveness-period is obtained by dividing line 1 by line 2.

(4) Line 4. The cost of one mowing operation is taken from line 5 of document C. Use the total cost of mowing the areas where PGRs would be applied.

(5) Line 5. The cost of all the mowing that would normally be required during the effectiveness-period is obtained by multiplying line 3 by line 4.

(6) Line 6. The savings recorded here is the cost of the mowings that would be eliminated by using PGRs.

(7) Line 7. Like the cost on line 4, the cost of a PGR application is taken from document C.

(8) Line 8. The net savings is the difference between the savings in mowing costs and the cost of applying the PGR (and herbicide, if needed).

(9) Line 9. The recommended use of the savings is recorded on line 9.

b. The completed document D for our example at Air Base Somewhere is shown in figure 6-5.

DOCUMENT D

Determination of Cost Effectiveness

Mowing Versus PGRs

PLACE: Air Base Somewhere DATE: 08/03/84

Description of Area:

Location: Runways and Taxiways

Size: 2300 acres

Special Considerations: Includes main grassy areas—between the runways, taxiways and aprons.

Time between operations: 2 weeks

Time of year: SPRING SUMMER FALL RAINY DRY
(Circle the most appropriate)

Grass Type: COOL SEASON WARM SEASON
(Circle the most appropriate)

		*Source**
1. EFFECTIVENESS PERIOD	8	From Table 6-2
2. NO. WEEKS BETWEEN PRESENT MOWING OPERATIONS	2	Local estimate
3. NO. OF MOWING OPERATIONS	4	(1) ÷ (2)
4. COST PER MOWING OPERATION	$ 53,928.91	Document C, line 5f
5. TOTAL COST DURING EFFECTIVENESS PERIOD	$215,715.64	(3) × (4)
6. SAVINGS	$107,587.82	(5) ÷ (2)
7. COST OF SPRAYING OPERATION	$ 49,397.33	Document C, line 5f

IF LINE 6 GREATER THAN LINE 7, THEN PGR IS COST-EFFECTIVE.

8. SAVINGS = $\underline{\$107,857.82}$ (LINE 6) − $\underline{\$49,397.33}$ (LINE 7) = $ 58,460.49

9. USE OF PROJECTED SAVINGS:

Project	*Cost*
Increase mowing on obstructed areas and fenced borders by 3 mowings to give once a week coverage during rapid growth season (100 acres @ $14,582.56 each mowing)	$ 43,747.68

*The figures in parentheses indicate lines of this document.

Figure 6-5. Determining Cost Effectiveness for "Air Base Somewhere."

(1) On line 1, the effectiveness-period of the PGR is shown in weeks. It is obtained from table 6-2.

(2) Line 2 shows that the parcel would normally be mowed every 2 weeks. The normal number of mowing operations during the effectivness-period of the regulator is then calculated by dividing line 1 by line 2, and the result is entered on line 3.

(3) The total cost of each mowing operation is found on line 5f of figure 6-3 to be $53,928.91, and this is recorded on line 4. The cost of the 4 normal mowing operations during the effectiveness-period is computed to be $215,715.64 on line 5. The effectiveness-period is based on an effectiveness-rate of 50 percent, so the PGR is expected to reduce growth, and thus the number of mowings, by 50 percent during this 8 week period. The expected savings in mowing costs because of using the PGRs is, therefore, found by dividing line 5 by 2 and is entered on line 6. Comparing the savings of $107,852.82 with the $49,397.33 cost of the regulator application (line 5f in figure 6-4), shows a net savings on line 8 of $58,460.49. The use of the PGR, therefore, appears to be cost-effective in this example.

(4) The manager should consider his or her project priority list and determine if the freed assets can be usefully employed elsewhere. On line 9, a recommendation is made to use the anticipated savings to increase the frequency of mowing obstructed areas and fenced borders on the base. It is explained that those areas could be maintained every week during the rapid growth season rather than once every 2 weeks.

6-9. A Method of Estimating Cost-Effectiveness:

a. The information in document C can also be used to develop a table of costs that give a quick estimate of when it would be cost-effective to use regulators. For our example at Air Base Somewhere, we have used costs in document C (figures 6-3 and 6-4) to develop table 6-3, showing the costs of individual mowing and spraying operations.

b. In table 6-3, it can be seen that it costs $19.13 an acre to apply the PGR, and it costs $14.27 to mow the large grassy area with tractor mowers. The mowing costs increase significantly, however, as the cutters become smaller. When an effectiveness-rate of 50 percent is used, we can estimate that PGRs can save about half the mowing cost. The question is whether this cost reduction be greater than the cost of applying the PGRs. With table 6-3, the manager can quickly estimate the cost-effectiveness of using PGRs in a given parcel.

c. For example, using growth regulators in the large grassy area along the runways and taxiways, which are normally mowed with tractor mowers, would require a savings of about two mowing operations to be cost-effective. (Actually, it would require $19.13 divided by $14.27, or 1.34 mowings). If the mowing operation were normally carried out every 4 weeks, there would be two mowings during the effectiveness-period. One of those mowings would be eliminated, for a savings of $14.27 per acre. Inasmuch as the cost of applying the regulator is calculated in this illustration to be $19.13 per acre, it would not be cost-effective to use PGRs in this case. If the mowing frequency were every 2 weeks, however, then there would normally be four mowings during the 8-week effectiveness-period. Two of these mowings would be eliminated, for a savings of $28.54 per acre, if the regulator were used. In this case, the $19.13 per acre cost of applying the regulator would be offset by the $28.54 savings per acre, and it would be marginally cost-effective.

Table 6-3. Costs of Operations for "Air Base Somewhere."

Cost Category	Spray PGR	Tractor Mower	Riding Mower	Power Mower	Weedeater	Source Doc. C
Equipment	$4,038	$14,768	$3,512	$3,362	$126	line 1d
Chemicals	35,880	-	-	-	-	line 2d
Operators	7,079	12,290	5,100	9,360	843	line 3g
Vehicles	162	1,473	143	118	8	line 4e
Drivers	888	-	784	646	46	line 4i

Cost Category	Spray PGR	Tractor Mower	Riding Mower	Power Mower	Weedeater	Source Doc. C
Total cost*	$44,000	$28,531	$9,539	$13,486	$1,015	
Acres	2,300	2,000	200	100	2.3	
Cost per acre	$19.13	$14.27	$47.70	$134.86	$441.30	

*Supervisor costs were not included under the separate tasks.

d. Applying PGRs would be cost-effective in the areas where the smaller mowers are used, even if only one mowing were saved. Applying a PGR on these smaller areas, however, may be more costly per acre than it was for the entire 2300 acre area. Therefore, realistic costs must be developed for each parcel being considered before a final decision is made.